SUISUN MARSH - LEVEE CONCEPTUAL MODEL

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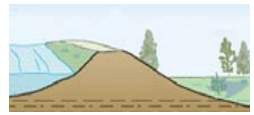
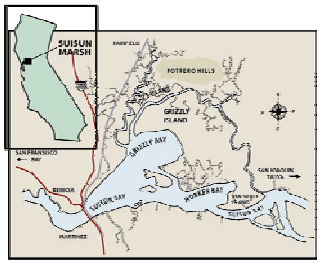
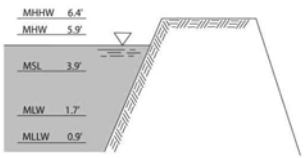


The Habitat Management, Preservation, and Restoration Plan for Suisun Marsh (Suisun Marsh Plan) is a multi-agency cooperative effort among state, federal, and local agencies, and private landowners to protect and enhance wildlife values, and water quality in the Suisun Marsh. A critical component of this effort is the development of conceptual models to describe the current state of knowledge, existing conditions, and effects of stressors on those conditions.



NATURAL and ANTHROPOGENIC PROCESSES

Suisun Marsh levees constantly experience dynamic pressure from fluctuating water levels that results in changes in soil structure and stability and can cause levee slumping or failure. Water levels in the marsh vary by about 6 feet from Mean Lower Low Water to Mean Higher High Water during each daily tidal cycle.



NAVD88 Tidal Datum for Tides at Bradmoor Island, Suisun Marsh (NOAA Preliminary Data, 2004)

Maintaining certain Suisun Marsh levees is necessary for continued flood protection of managed wetlands, county and state lands, infrastructure, residences, habitat, and water quality. Maintenance includes mowing, repair of slumping or eroded areas, rodent control, and spraying to control vegetation. However, regulatory constraints apply where waterside slopes provide habitat or foraging areas for threatened and endangered species.

Improvements to certain Suisun Marsh levees can increase flood protection and include raising heights, repairing damaged sections, rebuilding levees, and/or extending landside slopes. Such measures in certain areas not only provide increased flood protection but may result in improvements to critical habitat for State and federally threatened and endangered species.

LEVEES as HABITAT and PROTECTION FOR HABITAT

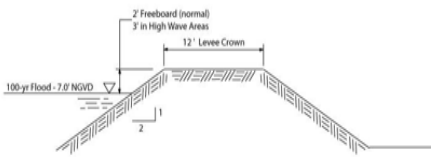
The building of levees has changed the marsh landscape from its pre-European era condition, and over time levees have become an integral component of this highly modified estuary.

The primary function of the Suisun Marsh levee system is to provide flood protection but over time habitats have developed along the levee slopes for native and introduced species. Common plant species growing along levees includes: annual grasses, blackberry, and coyote brush, Suisun Marsh aster, Delta tule pea and fennel. The Suisun song sparrow is commonly seen foraging or roosting in the shrubs along levees.

Most of Suisun Marsh land surface elevations are below sea level but levees are 4 to 8 feet above ground level.

The levees created 67,700 acres of managed tidal wetland. Prospective removal of levees may not result in recovery of the initial habitat lost during original construction of levees and in fact may result in the loss of existing native or introduced species habitat that has developed on the constructed levee slopes.

The levees have been built up progressively over the years using material dredged from adjacent waterways and, generally with little or no effort to meet specific engineering standards. In fact, the majority of the Suisun levees do not meet the standard Suisun Marsh levee configuration that was designed just over 20 years ago.

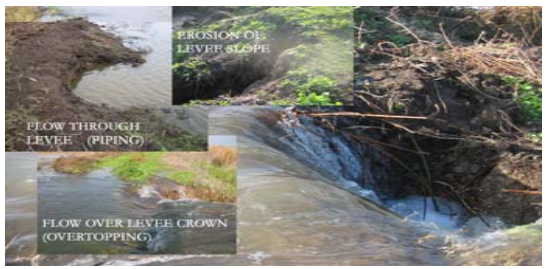


Standard Suisun Marsh Exterior Levee Section

LEVEE STABILITY STRESSORS

Since tidal wetlands in Suisun Marsh were diked and reclaimed for agriculture and waterfowl management, many marsh properties have flooded at least once and have exhibited deterioration or outright failure due to static and dynamic forces such as hydrostatic pressure, soil consolidation or settlement, overtopping, seepage/piping, and erosion. Other areas of increasing concern include: seismic vulnerability, land management (subsidence), and regulatory requirements.

Waves, Currents and Overtopping - Waves and tidal currents are the primary erosive forces on exterior levees. Waves, boat traffic, daily tidal flows, and high runoff events, undercut, scour, or just wash away levees over time. Some levees in the marsh erode or wash away due to the scouring action of water flowing over the levee crown and down the more vulnerable landside slope.



Soil Consolidation and Subsidence - The marsh is underlain by thick layers of unconsolidated organic peat and bay muds, which have limited capacity to hold the weight of existing or enlarged levees. These weak foundations significantly consolidate over time as the more material is added. This problem is particularly significant in the southeastern part of the marsh where settling of levees may equal the height of the placed fill within months of placement.

Seepage/Piping – Significant movement of water through a levee caused by; hydrostatic pressure, permeable material, poor maintenance, rodent burrowing, and soil cracking, may lead to erosion and carrying away of levee material (piping), enlarging the seepage path, and ultimately levee failure.

Seismic Vulnerability - The saturated unconsolidated marsh soils have limited capacity to bear the weight of levees and are vulnerable to the seismic shaking, resulting in loss of shear strength and failure.

Regulatory Requirements and Restrictions – Maintenance of Suisun Marsh levees falls under the jurisdiction or management of several agencies at the federal, State, and local levels (DFG/SRCD 2004). Permit applications and long review and approval times can be significant obstacles for initiating and completing work and may increase the potential risk for levee failures. This points out the direct conflict that exists between levees as habitat and levees as structures that provide flood protection.

LINKAGES

Levees serve multiple purposes within the Marsh as important components of a highly modified estuary. They protect national, statewide, and regional infrastructure, local and regional water quality, and play a critical role in protecting and providing a variety of habitats. Although levees are not considered part of the natural ecosystem, they serve as habitat for some species.

Management practices within Suisun Marsh's managed wetlands can create conditions which contribute to the oxidation of bulk soil organic matter, which may lead to local and regional ground subsidence, and in turn affect levee stability and increase the risk of failure. Improvements to counter this increased risk can cause conflicts with needs of threatened and endangered species, but may also provide additional incremental protection against regional salinity intrusion.

Maintenance of levees can impact existing habitat of threatened and endangered species but also prevents long-lasting environmental and water quality impacts that can result from unplanned levee failures. Delays in permit approval for levee maintenance and repair allows damages to continue or worsen resulting in increased costs. Restrictions on the use of rip-rap (for levee maintenance) and herbicides (to control vegetation) can result in greater environmental impacts with alternative measures. Further restrictions on timing, volume, and location of permitted activities often cause the work to be scheduled over several seasons, increasing costs and impacts to sensitive wildlife species.

Historically, levee side dredging was typically done with either a clamshell or dragline dredge and provided a relatively inexpensive way of levee maintenance and rehabilitation. The sloughs and channels held back by the levees are subject to State and federal regulation since they provide habitat for special-status plants and animals. Restricting dredging activities results in use of landward sources of borrow material which are typically high in organic content and less suitable for levee maintenance than bay mud. Although using this less desirable material is more convenient and less expensive than importing appropriate material, it may result in long term increased costs, deferred maintenance, reduced levee stability, and contribute to subsidence. Engineering principles and practical experience show that using mineral soils (dredged material from sloughs and channels) for levee construction and maintenance provides increased levee stability versus that provided by organic marsh soils.